

Education & Public Outreach

Astrobiology in a changing world: communicating about complex science in a complex cultural environment

Since the turn of this century, NASA's Astrobiology Program has focused increasing attention on communicating with external audiences – scientists, decision makers, the media, students and teachers, and other interested citizens. This focus has led to a number of new and innovative communication, public education, and public outreach activities. As a result, astrobiology has become a "household word." At the same time, though, astrobiology research has grown more complex and thus more challenging to explain to non-experts. This paper will examine some of the Astrobiology Program's 21st century communication, education and outreach activities, such as FameLab Astrobiology, the Astrobiology graphic history series, the NASA-Library of Congress Blumberg chair in astrobiology, a new initiative with the Center of Theological Inquiry and consider their contributions to greater public understanding of the science and the meaning of astrobiology. It also will speculate on possible new directions for communicating about astrobiology in the 21st century.

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Communication challenges facing NASA's Near-Earth Object Program and the International Asteroid Warning Network

NASA's Near-Earth Object Program has long faced challenges in communicating clearly and concisely with its various publics about NEO detection and tracking and identification of potentially hazardous NEOs. NASA's Near-Earth Object Program, a research and analysis program of the Planetary Science Division, Science Mission Directorate, was officially established in 1998. The NEO Program operated on a budget averaging \$4 million per year from fiscal year 1998 through fiscal year 2011. In April 2010, the President announced a new goal for NASA: a human mission to an asteroid. The President's fiscal year 2012 budget request included, and Congress authorized, \$20.4 million for an expanded NASA NEO observation program. The President's fiscal year 2014 budget request for NASA included \$105 million to begin work on an "asteroid redirect" mission, including \$40 million for the NEO Program. NASA consequently organized a three-part Asteroid Initiative (http://www.nasa.gov/mission_pages/asteroids/initiative/index.html). The NEO Program's role in this initiative is to provide information on the orbits and characteristics of NEOs that might be accessible for human missions and NEOs that might pose a hazard of colliding with Earth. With Congress, the White House, and other constituencies paying closer attention to NEOs and to planning for planetary defense against NEO impacts with Earth, NASA's NEO Program and the global NEO community are paying closer attention to communication strategy and planning. This paper will review discussions of communication challenges at the 2013 Planetary Defense Conference, the 2014 International Asteroid Warning Network, and the 2013 and 2014 NEO impact tabletop exercises conducted for NASA and the Federal Emergency Management Administration and identify near- and long-term NEO communication needs.

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DREAM2 Education and Public Outreach

The Dynamic Response of Environments at Asteroids, the Moon and moons of Mars (DREAM2) team builds on the work of its predecessor (DREAM), which was established under the auspices of the former NASA Lunar Science Institute, by taking a system-level integrated approach to examining environmentally- driven surface processes common to all airless bodies. The DREAM2 education and public outreach (E/PO) plan builds upon the successful DREAM E/PO program while also bringing DREAM2 and SSERVI content to new and expanded audiences. Based on the results of surveys issued to students who participated in the DREAM E/PO program, it was the direct face-to-face interaction with scientists that they valued the most. These results demonstrate the value of scientist involvement in E/PO efforts. The DREAM2 E/PO plan is designed to allow for increased and sustained interaction between scientists and the audiences DREAM2 will reach. DREAM2's E/PO plan aligns with three of the five goals of the Federal Committee on Science, Technology, Engineering, and Mathematics Education (CoSTEM): 1) Improve STEM instruction; 2) Enhance STEM experience of undergraduate students; 3) Better serve groups historically underrepresented in STEM fields. The DREAM2 E/PO team is also eager to partner with other SSERVI E/PO teams to extend our reach and impact and to share the exciting science efforts of the other institute teams. The keystone component of the DREAM2 E/PO program is a partnership with two academic departments and the on-campus middle school at Howard University (HU), a Historically Black College and University (HBCU) located in Washington, D.C. This partnership spans higher education, formal education, and outreach, and allows DREAM2 and SSERVI-related content to reach students and educators underrepresented in the STEM fields. The best practices gleaned by DREAM2 while working with HU will be shared with other SSERVI teams and the planetary science E/PO community. DREAM2's higher education efforts will provide opportunities for underrepresented undergraduate students in two areas: 1) Students in the HU Department of Physics and Astronomy will engage in authentic NASA research while learning about DREAM2, SSERVI-related content, and NASA and STEM career opportunities, and 2) Pre-service middle and high school science educators in the HU Department of Curriculum and Instruction will receive professional development on DREAM2 and SSERVI-related content, best practices for engaging students in science, and information about NASA and STEM career opportunities via the "DREAM2Explore" professional development workshop series. DREAM2's formal education E/PO efforts will provide in-service educators, including teachers at HU's Middle School for Mathematics and Science (MS2), with professional development, also via the "DREAM2Explore" professional development workshops. Our outreach efforts will focus on interacting with students at MS2 via classroom visits and other opportunities and with the public via participation in large outreach events like International Observe the Moon Night.

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Crowd sourcing, social media and citizen science

ASTEROID MINING AND SPACE SIMULATIONS WITH CITIZEN SCIENCE AND GAMING.

Michelle M. Cadieux, independent on various space teams. Community Safety Programs (MN nonprofit corp) (667 45th Ave NE, Mpls MN 55421, michellecadieuxmba@gmail.com Introduction: Many space companies are trying to find out how the economics of space mining will work. Many of these projects are being completed in simulations like NASA spaceappschallenge.com, Astropreneur.com game, 3d printer simulations like D Space, NASA Dark Side of The Jam, and more. Citizen Science exploration with groups like PongSat, are helping to gather intel on space that will affect exploration in new ways. PongSat has it's first micro-gravity lab now. Crowdfunding has been successful for raising money for projects like NanoSat, LiftPort and others. This paper will aim to explore some of what has been successful, and what hasn't when working on projects aimed at supporting space mining. Hackathons, business start up competitions are a good way to get teams together for a quick weekend to brainstorm ideas. Other competitions like Lunar X Prize and Mars Return Sampling and the NASA Systems Engineering Mars Sampling project for Saylor online university are also good places to find teams working on this. NASA currently has the <http://CreateTheFuture.com> contest on. Crowdsourcing for volunteers should only be used for nonprofit teams. There have been changes in legislation that crack down on the use of unpaid interns and volunteers for profit making companies. There are also very tricky tax rules about assets acquired for a nonprofit should only be used for a nonprofit and not for profit entities. NASASpinoff.com has always done a good job of showcasing how technologies that have been developed for space are used on earth. Memory foam and other products have been developed, even if velcro, tang, and teflon actually were not. These technologies can help to establish the business case for funding projects, in a climate that is reluctant to fund space projects without a clear ROI. Astropreneurs is a game that hopes to help demonstrate the space business model. It was developed at a StartupWeekend with Paul Fuller, and worked on more at NASA's Dark Side of the Jam gaming hackathon with myself and a team, it has continued to grow with developer resources. Michelle Cadieux, MBA. Michelle has been involved with Leeward Space Foundation, LiftPort Space Elevator as the VP, Space StartupWeekend.org, Silicon Valley Space Center org , and more. She has worked in satellites with Lockheed, SolSpike.com rocket powered boot with SolarSystemExpress.com and Pong Sat conference with SVSC, LunarCubes.com, and many other events. She's a supporter of XPrize Team Jurban, and board with Team Prometheus.org.

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Remote, In Situ and Synchrotron Studies for Science and Exploration Education and Public Outreach

Through a partnership with the Alan Alda Center for Communicating Science at Stony Brook University, the RIS4E Education and Public Outreach (EPO) team will create a sophomore-level undergraduate science journalism Special Topics course. The RIS4E Special Topics course is being developed in response to a need to create journalists with an understanding of the scientific process. Over the course of a semester, students enrolled in the RIS4E Special Topics course will be exposed to the breadth of scientific investigations being undertaken by the team. Members of the RIS4E science team will be invited to be guest lecturers in the Special Topics Course throughout the semester. Tours of research facilities used by RIS4E researchers are included as part of the course as a way to expose journalism students to scientific research in action. Two students from each class will be competitively selected to accompany members of the RIS4E field team as they conduct research in Hawaii and New Mexico. Students who attend the field excursions will be expected to report on RIS4E team activities. By providing the students with access to RIS4E content, team members, and facilities, students will have an opportunity to learn more about the science of RIS4E, to develop their science journalism skills, and to share the exciting work being done by the RIS4E team with the public.

Training the Next Generation of Student AmbassadorsAs part of their research, RIS4E team members will be mentoring 6 undergraduate students per summer. We will provide these students, as part of their research experience, with professional development in best practices in engaging girls in Science, Technology, Engineering, and Mathematics (STEM) content. Additionally, we will be assisting all of the undergraduate interns with identifying education activities in which the interns can participate once they return to their home institutions. Students will then be expected to apply what they learned in their professional development trainings to the educational activities in which they participate.

Bringing the Science of RIS4E to the General PublicWe will bring the science of the research team to the public through International Observe the Moon Night (InOMN), an annual public outreach event dedicated to inspiring the public to learn more about the Moon. Since 2010, InOMN has reached over a million people worldwide, and continues to be an exciting way to engage the public in conversations about cutting edge scientific research. RIS4E science will be featured at InOMN events associated with science team members around the country.

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FINESSE Education and Public Outreach Program

The Field Investigations to Enable Solar System Science and Exploration (FINESSE) team will conduct a science and exploration field-based research program aimed at generating strategic knowledge in preparation for the human and robotic exploration of the Moon, near-Earth asteroids, and the martian moons Phobos and Deimos. Field investigations in the analog environments of Craters of the Moon National Monument and Preserve in Idaho and at the West Clearwater Lake Impact Structure in northern Canada will address scientific questions pertaining to volcanism and impact science. The FINESSE Education and Public Outreach (E/PO) program will leverage the team's field investigations as well as educational partnerships to share the excitement of lunar, near-Earth asteroid, and martian moon science and exploration locally, nationally, and internationally. The FINESSE E/PO team will coordinate a SSERVI Seminar Speaker Series, offering virtual public presentations designed to share FINESSE science and enhance the public's understanding of NASA's science and exploration goals. These presentations will be advertised on a FINESSE website; through the Lunar List Listserv, a listserv that reaches a community of lunar scientists and enthusiasts; and to NASA Solar System Ambassadors, a cadre of enthusiastic volunteers nationwide who share space science and exploration with their local communities. All talks will be recorded and archived on the FINESSE website. Presentations drawn from this series will also be offered to the NASA Museum Alliance, a network of over 1100 professionals at more than 550 informal education centers nationwide and 60 international centers who incorporate this content into NASA-themed educational activities and exhibits at their institutions. The FINESSE team will also share FINESSE content at venues local to their institutions and field sites. Team members at NASA Ames Research Center will support the Haven House Family Shelter Speaker Series, a program that brings NASA science and technology to underprivileged children near the Center and provides them with opportunities and guidance to pursue careers in STEM fields. Team members at NASA Goddard Space Flight Center (GSFC) will support the Gerald Soffen Lecture Series, a public lecture series that showcases exciting work being conducted at GSFC and by GSFC scientists. At Craters of the Moon, the FINESSE team will partner with the Idaho Space Grant Consortium to include teachers in their field investigations, teaching them about FINESSE science and exploration practices through rich participatory experiences. Team members will also offer to give talks at evening campground programs during field campaigns. The team is committed to reaching out to the community near the West Clearwater Lake impact site as well and has established a partnership with the Centre for Northern Studies (CEN: Centre d'Études Nordiques). FINESSE team members will offer to speak at student and community events at a CEN field station that serves Inuit and Cree schools. Additionally, the FINESSE team will support International Observe the Moon Night events at team member institutions and Craters of the Moon, as well as other SSERVI central office outreach efforts, as directed.

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Lessons Learned on Professional Development for Future Teachers: The Solar System Exploration Pre-service Teacher Institute

The Solar System Exploration Pre-service Teacher Institute is a formal education activity co- led by the JHU Applied Physics Laboratory and the Lunar and Planetary Institute. Funding for this institute is supplied by the APL-VORTICES SSERVI Team (PI Bussey). The institute focuses on engaging pre-service educators, mainly from minority serving institutions, with Solar System science and research. These future middle school STEM teachers will serve as role models to their students. Through these workshops, we are creating a pipeline of opportunities to help future teachers as they pursue their degrees, and will continue partnering with them and serve as resources for them as they encourage their students to pursue STEM interests and careers. This presentation will share the materials developed and lessons learned so far in serving this critical audience. The development of this workshop is being informed by pre-service teacher needs, both from current research on teacher preparation in Earth and space sciences, and from needs expressed by college and university science education faculty who prepare future teachers. The institute also incorporates Nature of Science, explicitly incorporating discussions on what science is, what a theory is, and applying these concepts to the activities and SSERVI research being shared. Additionally, this program connects participants to ongoing research. Participants discuss VORTICES and other SSERVI research directly with our scientists and engineers, and have opportunities to discover how and why research is conducted. Finally, the institute explicitly models (and provide opportunities for participants to practice) educational best-practices such as formative assessment, uncovering and addressing student misconceptions, facilitating learning discussions, wait time, inquiry, and the use of data for mini-research projects. The workshops reflect the NSES for professional development, involving participants in learning and modeling best teaching practices. Each day examines “planetary basics” (orbital characteristics, phases, eclipses) and delves deeply into lunar and small-body science, through a variety of hands-on and inquiry-based activities. At the end of each institute, attendees conduct activities with students to gain experience and familiarity with both the content and the materials. We complement the extensive lunar and asteroidal science classroom materials that APL, LPI, and the NASA education community have created by adding materials based on the science gained by our VORTICES team. We will post the materials to the team’s website and also to the Central Node E/PO site, and materials can also to be integrated into the larger SSERVI formal education initiative. We have initiated a partnership with other SSERVI team E/PO programs on pre-service educator opportunities to leverage our resources and avoid replication. Further information on the Solar System Exploration Pre-Service Teacher Institute is at <http://www.lpi.usra.edu/education/workshops/SSE/>.

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The art and science of small bodies in our solar system.

To prepare students for a highly visual and tactile workforce, it is imperative that today's classrooms keep up with instructional and informational technologies that are the media of modern life. Engaging students with authentic data sets, real world questions and investigations through a variety of learning strategies offers students and teachers a seamless and coordinated curriculum that is immediately usable in most classrooms across America, particularly those serving at-risk Title I populations. Our SSERVI Education/Public Engagement (EPE) program and activities promote STEAM literacy using the excitement of the success of recent missions and the SSERVI teams. The planned outreach activities and materials highlight not just science, engineering, math, and technology but also how they may be infused with the arts. Examples include, but are not limited to, artistic drawings of the features and changing 'faces' or phases of the moon and morphologic interpretations based on solar incidence angle. In summer 2014, our SSERVI EPE team will work with lead teachers and artists from around the SC Lowcountry to develop arts-infused STEM curricula and tactile graphics to incorporate into a 6-week summer institute for students from underrepresented communities. STEM content will include the origin and evolution of the moon and small bodies in our solar system. We will work with musicians, visual artists, theatre artists, storytellers/creative writers, and dancers. The content will be based on the Next Generation Science Standards and ELA/visual arts standards. At the initial teacher and artist training, the team will share the NASA science and exploration initiatives, the importance of art and writing to problem solving and critical thinking skills, and the need to be proactive in making all materials accessible for ALL learners. Tactile graphics will be used to reinforce content. In South Carolina, among underrepresented communities, there is a 4.5% loss in knowledge retention over the summer. Through this hands-on program, students are expected to increase their knowledge retention, thereby overcoming this learning barrier. In addition to the STEAM curricula, we will develop and share content through stories and other communication media (e.g. tactile books, fiction and nonfiction, songs).

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Center for Lunar Science and Exploration E/PO

The Center for Lunar Science and Exploration (CLSE) E/PO integrates its well-established solar system education programs into the SSERVI portfolio. CLSE E/PO is leading a suite of exciting programs that strengthen the future science workforce, attract and retain students in STEM disciplines, and develop advocates for the exploration of the Moon and asteroids. Specific program efforts focus on the need for high school programs that highlight research experiences emphasizing the nature of science and scientific inquiry and inspire STEM career decisions, and materials for informal education venues to engage the public. The Exploration of the Moon and Asteroids by Secondary Students (ExMASS) program offers secondary students the opportunity to participate in authentic, data-rich, open-inquiry experiences. ExMASS enhances their Earth and space science content knowledge, attitudes toward science and science careers, and understanding of the nature of science and scientific inquiry. The program builds on the CLSE's highly successful High School Lunar Research Projects, a program run under the former NASA Lunar Science Institute. The ExMASS program strengthens the pipeline by articulating explicit paths from high school to higher education science studies. The CLSE E/PO team will create two new asteroid traveling library exhibits to complement the team's current inventory of lunar exhibits. Collectively, these exhibits will engage the public in lunar and asteroid science and exploration by presenting current SSERVI science and exploration topics. In partnership with CosmoQuest, CLSE E/PO will conduct monthly webcasts featuring members of the CLSE science team and other SSERVI science team members. These webcasts will serve to engage the general public, increase advocacy for NASA science and exploration, and provide a means for the general public to enter the NASA pipeline. CLSE E/PO will also host observing events to educate the public about SSERVI, SMD, and NASA science and exploration. These events are theme-based and include theme-aligned, hands-on learning activities for families, opportunities to interact with scientists, short public-focused presentations by scientists, and night sky viewing. Evaluation will be conducted across all CLSE E/PO programs and activities. The purpose of these evaluation activities is to inform the LPI-JSC E/PO Team of the program's successes and to allow the team to make data-driven modifications when necessary. The CLSE E/PO team is also committed to collaborating with SSERVI Central and other SSERVI teams; assisting with educator workshops, sharing SSERVI team science in our programs, collaborating on webcasts and collaborating on events such as InOMN and SMD mission outreach. For more information, please contact the CLSE E/PO lead, Andy Shaner, at shaner@lpi.usra.edu or 281-486-2163.

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Lunar Orbiter Image Recovery Project Education and Public Outreach

The Lunar Orbiter Image Recovery Project (LOIRP) was founded in 2007 to recover Lunar Orbiter mission imagery from original analog data tapes recorded as the images first arrived on Earth between 1966-1967. A large part of our effort was generating public visibility for our efforts so as to inform people what we were doing but also to generate support for the continued funding of our project. We will discuss the origin of the project, how we engaged the public from the onset, how we translated public interest into support, and how we intend to preserve the output of our project for posterity. We will also discuss the memes that emerged and soon came to characterize our project i.e. use of an abandoned fast food joint, discarded hardware, forgotten engineering, the expertise of retired senior citizens, and how this resonated with the Hacker, DIY, Maker, and citizen science communities. We will also discuss how crowd funding became a crucial part of our project. We will also discuss the implications for other collaborations NASA may wish to consider in the years ahead.

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Treaty Making for Global Exploration

The 1967 Treaty on the Peaceful Uses of Outer Space was formulated more 50 years ago. Since that time many significant technological developments and the emergence of leading potentials propose the requirement for a revisionary basis and for extension of the original treaty consensus into further productivity. This discussion outlines the primary topics of interest, and lines of approach with objectives towards the stable international backgrounds and the enhancement of the Global Space Exploration agenda. The US based treaty initiative may be prepared through placement of a specialized unit at the Library of Congress. Recommendation is for a three phase approach: initial model, policy extension, authorization and public distribution. An early presentation to the international community can made available at UNISPACE IV which is currently under arrangement. Areas which may be addressed by additional clauses and extensions include: 1. Sensitive space technologies (nuclear, fusion and laser etc) 2. International collaboration (road map development) 3. Security interchanges basis (data) and non-proliferation 4. Global data management and utilization (developmental) 5. Civil society assurance against misuse of global data 6. Space debris mitigation and removal 7. Asteroid mitigation 8. Space tourism and commercial flight safety